NDA-CDS 2 2024

GS

LIVE

PHYSICS

CLASS 6

NAVJYOTI SIR

SSBCrack EXAMS

06 July 2024 Live Classes Schedule

8:00AM	06 JULY 2024 DAILY CURRENT AFFAIRS	RUBY MA'AM
9:00AM	06 JULY 2024 DAILY DEFENCE UPDATES	DIVYANSHU SIR

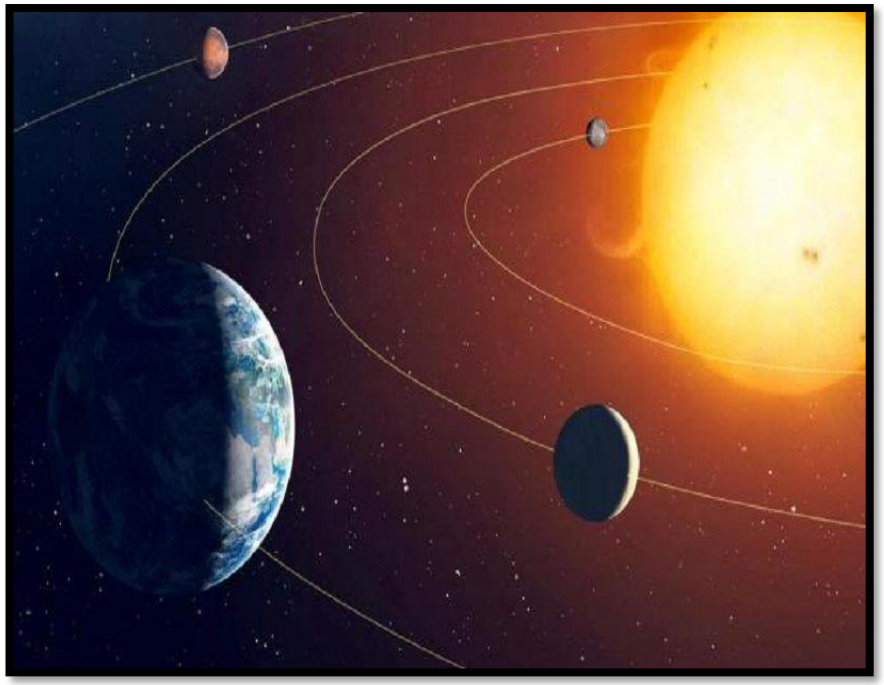
NDA 2 2024 LIVE CLASSES

11:30AM	GK - WORLD HISTORY - CLASS 2	RUBY MA'AM
1:00PM	GS - PHYSICS - CLASS 6	NAVJYOTI SIR
4:00PM	MATHS - PROBABILITY - CLASS 2	NAVJYOTI SIR

CDS 2 2024 LIVE CLASSES

11:30AM	GK - WORLD HISTORY - CLASS 2	RUBY MA'AM
1:00PM	GS - PHYSICS - CLASS 6	NAVJYOTI SIR

MOTION



WHAT WILL WE STUDY ?

- Scalar and Vectors
- Terms associated with Motion of a body
- Graphs describing Motion
- Projectile Motion
- Uniform Circular Motion

SCALARS AND VECTORS

- **Scalars : Those physical quantities which require only magnitude but no direction for their complete representation are called scalars.**
  Example - Distance, Speed, work, mass, density etc.
- **Scalars can be added, subtracted, multiplied or divided by simple algebraic laws.**

(number + unit)

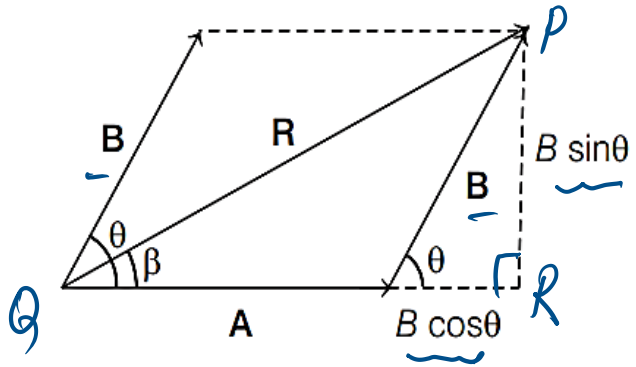
15 m ; 16 km/h

4 g cm^{-3}

- **Vectors : Those physical quantities which require magnitude as well as direction for their complete representation.**
- **Examples are – Displacement , Velocity, Acceleration, Force etc.**
- **Vectors have other laws for addition , subtraction and multiplication.**

VECTOR ADDITION

If two vectors acting at a point are represented in magnitude and direction by the two adjacent sides of a parallelogram draw from a point, then their resultant is represented in magnitude and direction by the diagonal of the parallelogram drawn from the same point.



Resultant of vectors **A** and **B** is given by

$$R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$$

If the resultant vector **R** subtends an angle β with vector **A**, then

$$\tan\beta = \frac{B\sin\theta}{A + B\cos\theta} \qquad \beta = \tan^{-1}\left(\frac{B\sin\theta}{A+B\cos\theta}\right)$$

$\vec{A}$ → vector

A — magnitude

parallelogram law of vector addition

In right triangle PQR,

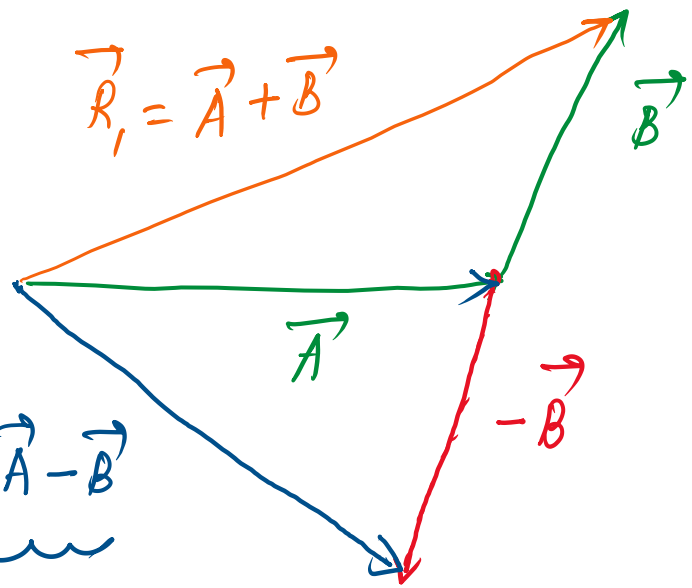
$$(A+B\cos\theta)^2 + (B\sin\theta)^2 = R^2$$

$$R^2 = A^2 + B^2 + 2AB\cos\theta$$

Case I : $\theta = 180^\circ$

$$R^2 = (A-B)^2 \Rightarrow R = A-B$$

Case 2 : $\theta = 0^\circ \Rightarrow R^2 = (A+B)^2 \Rightarrow R = A+B$



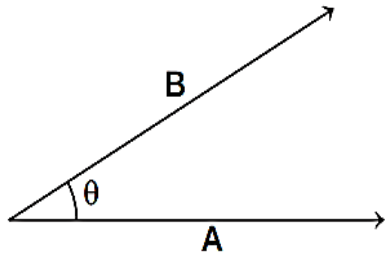
$$\vec{R}_2 = \vec{A} - \vec{B}$$

$$= \vec{A} + (-\vec{B})$$

VECTOR MULTIPLICATION

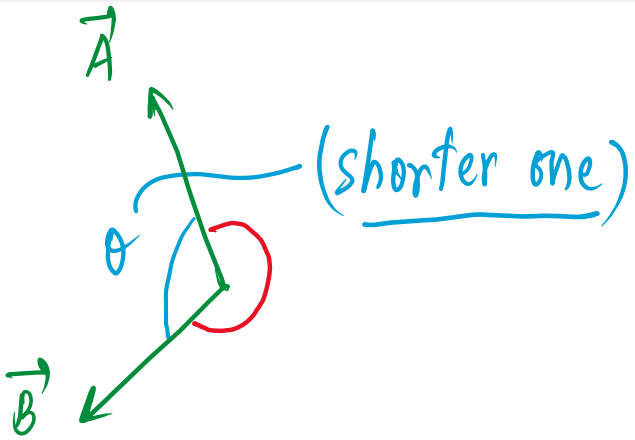
Scalar or Dot Product of Two Vectors

The scalar product of two vectors is equal to the product of their magnitudes and the cosine of the smaller angle between them. It is denoted by · (dot).



(number as result) $\mathbf{A} \cdot \mathbf{B} = AB \cos\theta$

The scalar or dot product of two vectors is a scalar.

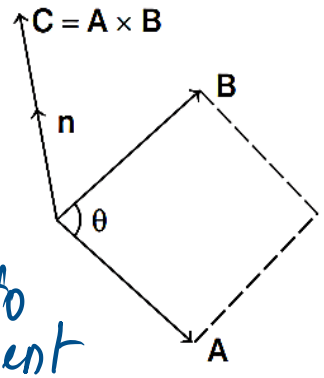


(shorter one)

Vector or Cross Product of Two Vectors

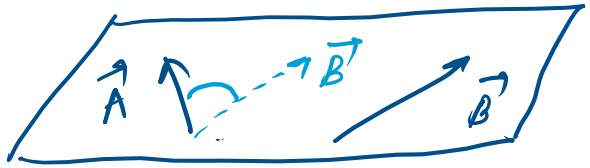
The vector product of two vectors is equal to the product of their magnitudes and the sine of the smaller angle between them. It is denoted by × (cross).

$\mathbf{A} \times \mathbf{B} = AB \sin\theta\, \hat{\mathbf{n}}$ ✓ (vector as result)



$\hat{n}$ – unit vector in perpendicular direction.

$\hat{a} = \frac{\vec{A}}{A}$ (used to represent direction) — magnitude = 1



$\uparrow$ dir $(\vec{B} \times \vec{A})$

dir. $(\vec{A} \times \vec{B})$ $\downarrow$

$|\vec{A} \times \vec{B}| = AB \sin\theta$

$|\vec{B} \times \vec{A}| = BA \sin\theta$

magnitudes are the same,

RESOLUTION OF VECTORS

If any vector **A** subtends an angle θ with *X*-axis, then its

horizontal component, $A_x = A\cos\theta$

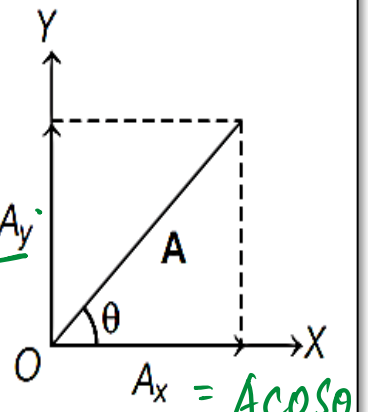
Vertical component, $A_y = A\sin\theta$

Magnitude of vector, $A = \sqrt{A_x^2 + A_y^2}$

$$\tan\theta = \frac{A_y}{A_x}$$

$$\text{Angle, } \theta = \tan^{-1}\left(\frac{A_y}{A_x}\right)$$

$A\sin\theta = A_y$



$A_x = A\cos\theta$

Terms Associated with Motion

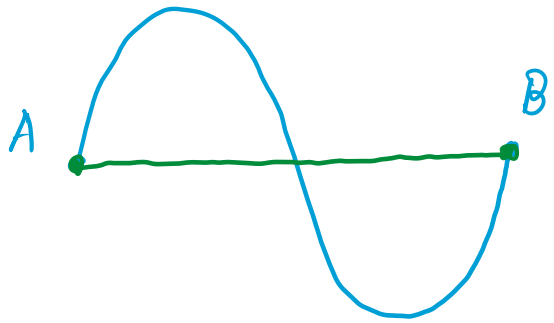
- Distance
- Displacement
- Speed
- Velocity
- Average Speed and Velocity
- Acceleration

1. **DISTANCE :** The length of the actual path covered by an object.

- It is a scalar quantity and it can never be zero or negative during the motion of an object. Its SI unit is metre.

2. **DISPLACEMENT :** The shortest distance between the initial and final positions of any object during motion.

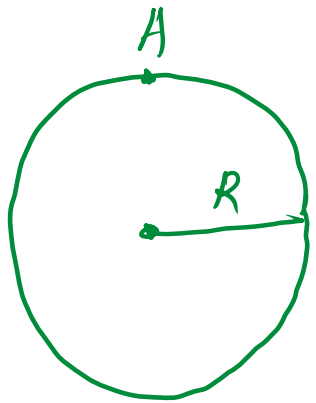
- The displacement of an object in a given time can be positive, zero or negative.
- It is a vector quantity. Its SI unit is metre.



Distance – Length along the curve

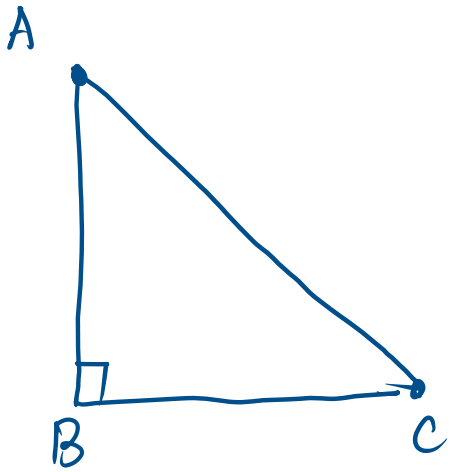
Displacement – Length along straight line segment

Displacement $\leq$ Distance



Distance (A to A) = $2\pi R$

Displacement (A to A) = 0



Dist(A − B − C) = AB + BC

Disp. (A − B − C) = AC

3. SPEED :

$$\text{Speed } (v) = \frac{\text{Distance travelled } (s)}{\text{Time taken } (t)}$$

- **Its SI unit is m/s. It is a scalar quantity.**

4. VELOCITY :

$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time taken}}$$

(speed + direction)

- **The velocity of an object can be positive, zero or negative.**
- **It is a vector quantity. Its SI unit is m/s.**

5. ACCELERATION :

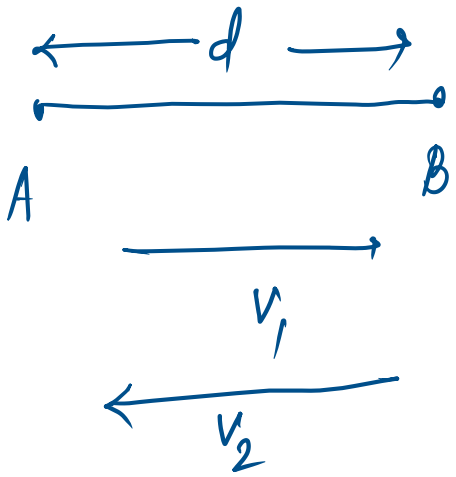
$$\text{Acceleration } (a) = \frac{\text{Change in velocity } (\Delta v)}{\text{Time interval } (\Delta t)}$$

- It is a vector quantity as well. Its SI unit is m/s^2 .
- Acceleration can be positive, zero or negative. Positive acceleration means velocity increasing with time, zero acceleration means velocity is uniform while negative acceleration (retardation/deceleration) means velocity is decreasing with time.

- **<u>UNIFORM SPEED</u> : If an object covers equal distances in equal intervals of time.**
- **<u>NON-UNIFORM OR VARIABLE SPEED</u> : If an object covers unequal distances in equal intervals of time and vice-versa.**

- **<u>AVERAGE SPEED</u> :**

$$\text{Average speed} = \frac{\text{Total distance travelled}}{\text{Total time taken}}$$



$$\text{avg. speed} = \frac{d+d}{t(A-B)+t(B-A)} = \frac{2d}{\frac{d}{v_1}+\frac{d}{v_2}} = \left(\frac{2v_1v_2}{v_1+v_2}\right)$$

- **INSTANTANEOUS SPEED :**

$$\text{Instantaneous speed} = \lim_{\Delta t \to 0} \frac{\Delta s}{\Delta t} = \frac{ds}{dt}$$

- **Uniform , Average and Instantaneous velocity will have the same formula , replacing distance with displacement.**

- **AVERAGE ACCELERATION:**

  If a particle is accelerated for a time t_1 with acceleration a_1 and for a time t_2 with acceleration a_2 , then average acceleration ,

$$a_{av} = \frac{a_1 t_1 + a_2 t_2}{t_1 + t_2}$$

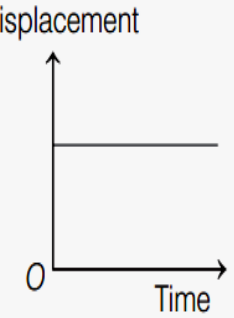
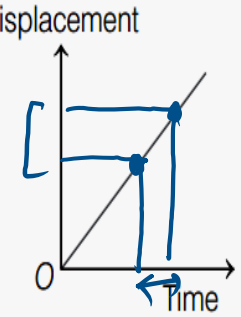
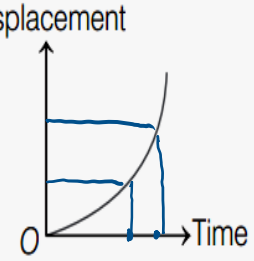
- **INSTANTANEOUS ACCELERATION:**

$$a_{inst} = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} = \frac{dv}{dt}$$

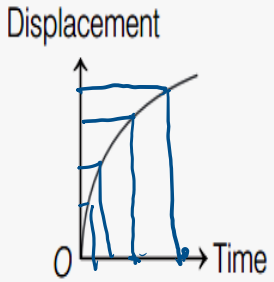
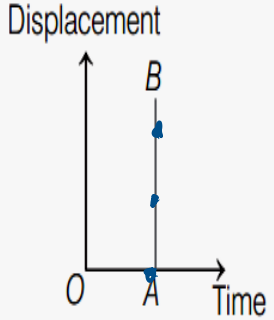
$$a = \frac{d}{dt}(v) = \frac{d}{dt}\left(\frac{ds}{dt}\right) = \frac{d^2 s}{dt^2}$$

$$a = \frac{d^2 s}{dt^2}$$

DISTANCE -TIME GRAPHS

Condition	Graph
For a stationary body	
Body moving with a constant velocity	
Body moving with a constant acceleration	

Slope gives speed/velocity.

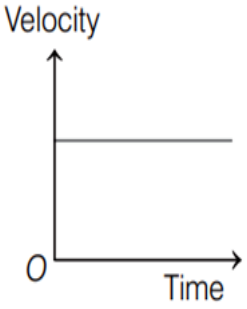
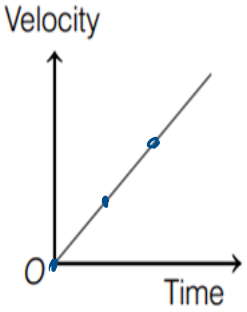
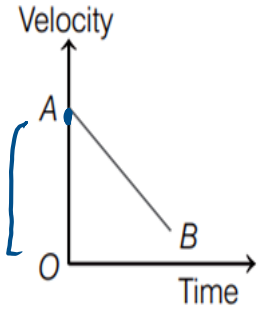
Body moving with a constant retardation	
Body moving with infinite velocity. But such motion of a body is never possible.	

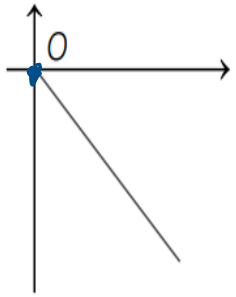
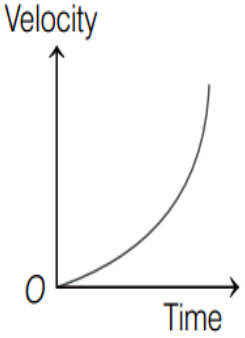
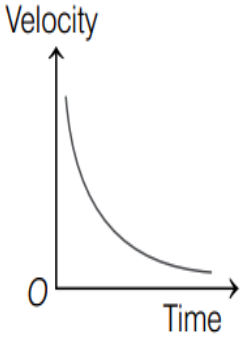
Slope = $\frac{\text{change in y-axis points}}{\text{change in x-axis points}}$ =

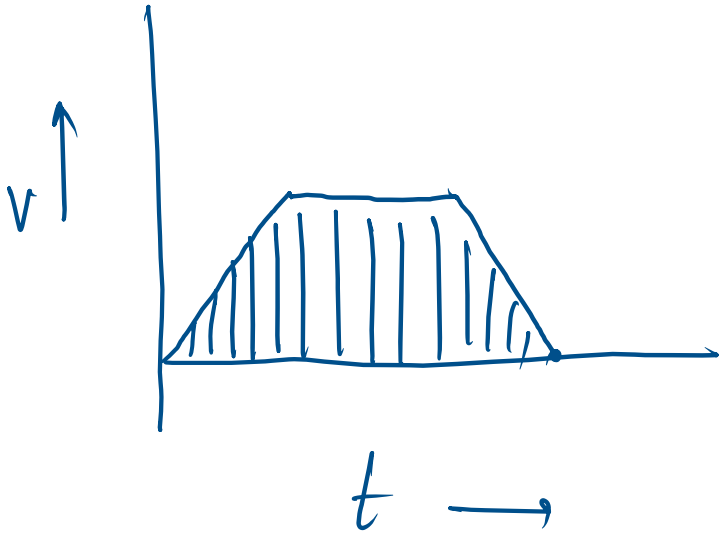
= $\frac{\text{change in disp.}}{\text{change in time}}$ = Velocity

VELOCITY -TIME GRAPHS

Slope gives acceleration. Area gives distance covered.

Condition	Graph
Moving with a constant velocity	
Moving with a constant acceleration having zero initial velocity	
Body moving with a constant retardation and its initial velocity is not zero	

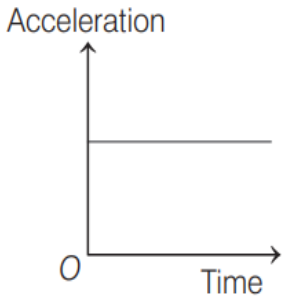
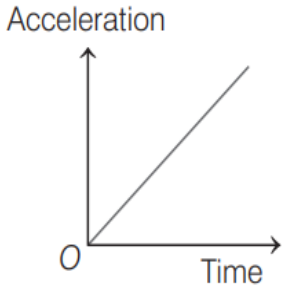
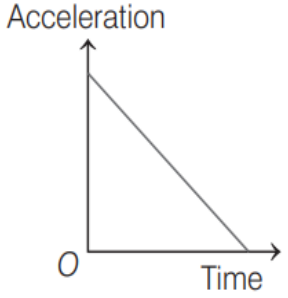
Moving with a constant retardation with zero initial velocity	
Moving with increasing acceleration	
Moving with decreasing acceleration	



area under v-t graph = distance covered by body.

Slope = acceleration = $\frac{\text{change in velocity}}{\text{change in time}}$

ACCELERATION -TIME GRAPHS

Condition	Graph
When object is moving with constant acceleration	
When object is moving with constant increasing acceleration	
When object is moving with constant decreasing acceleration	

EQUATIONS OF UNIFORMLY ACCELERATED MOTION

If a body starts with velocity (u) and after time t its velocity changes to v, if the uniform acceleration is a and the distance travelled in time t is s, then the following relations are obtained, which are called equations of uniformly accelerated motion.

(i) $v = u + at$

(ii) $s = ut + \frac{1}{2}at^2$

(iii) $v^2 = u^2 + 2as$

(iv) Distance travelled in nth second.

$$s_n = u + \frac{a}{2}(2n - 1)$$

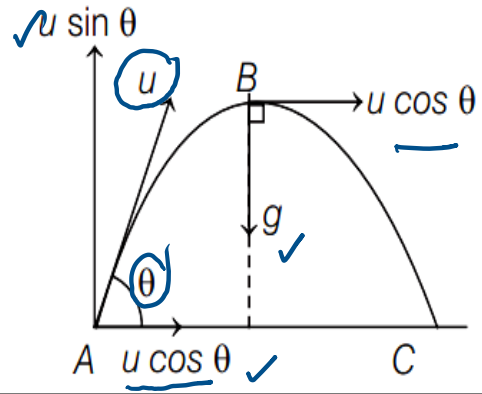
u – initial velocity
v – final velocity
a – acceleration
s – distance
t – time taken

- **For free fall under gravity , use a = g (Accleration due to gravity),** $\sim 10\ m/s^2$ (approx.) $= 9.8\ m/s^2$
- **For a body thrown upwards , use a = - g**

PROJECTILE MOTION

- **When any object is thrown from horizontal at an angle θ, then it moves on a parabolic path , the object is called projectile and its motion is called projectile motion.**

If any object is thrown with velocity u, making an angle θ, from horizontal, then



parabolic path,

PROJECTILE MOTION

Time of flight It is defined as the total time for which the projectile remains in air.

$$T = \frac{2u \sin\theta}{g}$$

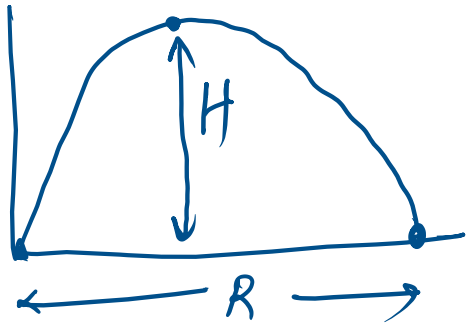
Maximum height It is defined as the maximum vertical height covered by projectile. (H)

$$H = \frac{u^2 \sin^2\theta}{2g}$$

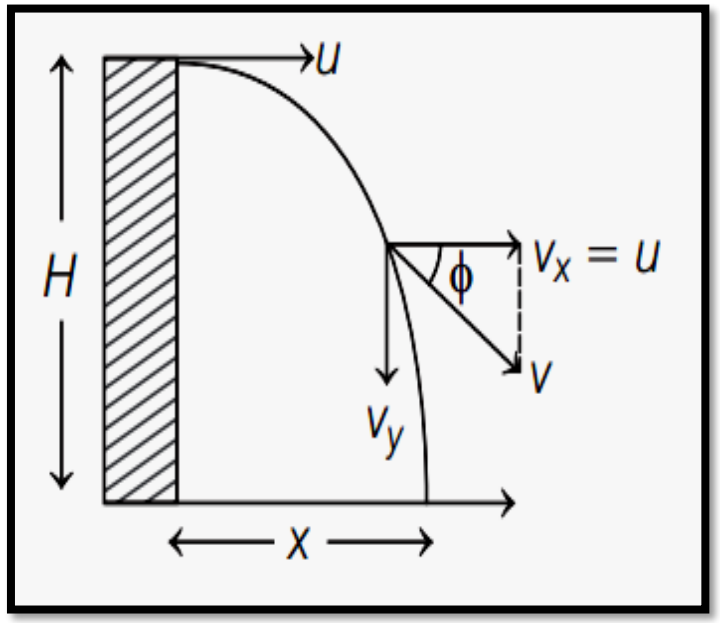
Horizontal range It is defined as the maximum distance covered in horizontal distance.

(R)

$$R = \frac{u^2 \sin 2\theta}{g}$$



PROJECTILE PROJECTED FROM SOME HEIGHT

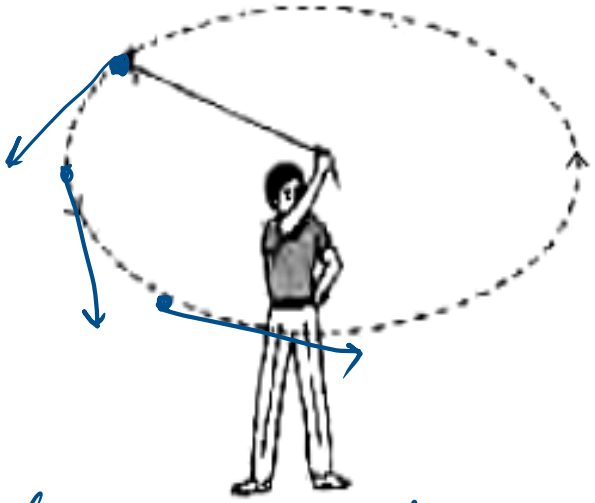


Time of flight, $T = \sqrt{\frac{2H}{g}}$

Horizontal range, $x = uT = u\sqrt{\frac{2H}{g}}$

UNIFORM CIRCULAR MOTION (UCM)

- **If the magnitude of the velocity of the particle in circular motion remains constant, then it is called uniform circular motion.**



(Tangential at every point)

At every point, velocity will be changing as the direction is changing.

TERMS ASSOCIATED

1. **Angular Displacement :**

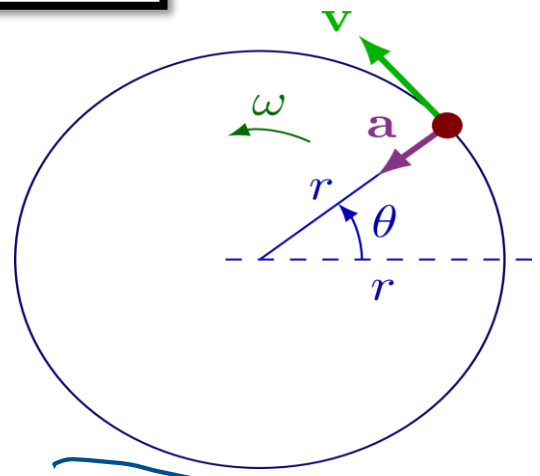
$$\text{Angular displacement } (\Delta\theta) = \frac{\Delta s}{r}$$

Its SI unit is radian(rad).

2. **Angular Velocity :**

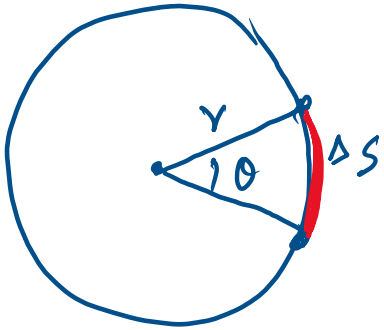
$$\text{Angular velocity } (\omega) = \frac{\Delta\theta}{\Delta t}$$

Its Unit is rad/s.



$$\omega = \left(\frac{\Delta s}{r}\right)\frac{1}{\Delta t} = \left(\frac{\Delta s}{\Delta t}\right)\frac{1}{r}$$

$$\omega = \frac{v}{r}$$



$$\frac{\theta\ (\text{in radian})}{(\text{displacement})} = \frac{\Delta s}{r}\ \frac{(\text{arc-length})}{(\text{radius})}$$

$$\omega \times r = v$$

Linear velocity

angular velocity

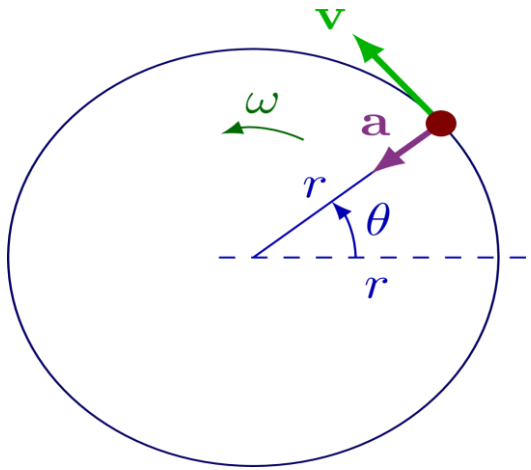
TERMS ASSOCIATED

3. **<u>Centripetal Acceleration :</u> In circular motion, an acceleration acts on the body, whose direction is always towards the centre of the path. This acceleration is called centripetal acceleration.**

$$a = \frac{v^2}{r} = r\omega^2$$

Linear velocity

angular velocity



$$a = \frac{(r\omega)^2}{r} = \frac{r^2\omega^2}{r} = r\omega^2$$

SUMMARY

- Scalars and Vectors
- Motion and Terms associated
- Graphs showing motion (s – t , v - t , a - t)
- Equations for Uniformly accelerated motion
- Projectile Motion and Formulas
- Uniform Circular Motion and Terms Associated

1. The Area Under Speed-time Graph Gives :

A. Acceleration

B. Velocity

C. Distance

D. None of the Above

1. The Area Under Speed-time Graph Gives :

A. Acceleration

B. Velocity

C. Distance

D. None of the Above

2. If an object moves with constant velocity then which one of the following statements is NOT correct ?

(a) Its motion is along a straight line

(b) Its speed changes with time

(c) Its acceleration is zero

(d) Its displacement increases linearly with time

2. If an object moves with constant velocity then which one of the following statements is NOT correct ?

(a) Its motion is along a straight line

(b) Its speed changes with time

(c) Its acceleration is zero

(d) Its displacement increases linearly with time

Answer: B

3. An object moves along a curved path. The following quantities may remain constant during its motion.

A. Speed

B. Velocity

C. Magnitude of Acceleration

D. Both A and C

3. An object moves along a curved path. The following quantities may remain constant during its motion.

A. Speed

B. Velocity

C. Magnitude of Acceleration

D. Both A and C

4. An object is moving with uniform acceleration a. Its initial velocity is u and after time t its velocity is v. The equation of its motion is $v = u + at$. The velocity (along y-axis) time (along x-axis) graph shall be a straight line

(a) passing through origin

(b) with x-intercept u

(c) with y-intercept u

(d) with slope u

Answer: C

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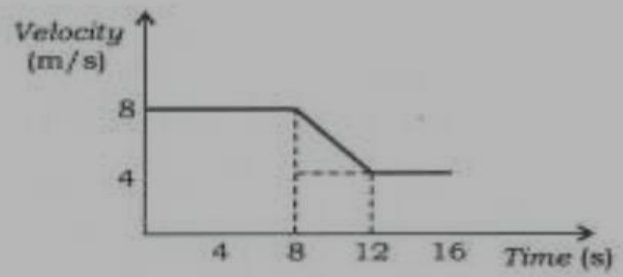
SSBCrack EXAMS

5. Consider the following velocity and time graph :



Which one of the following is the value of average acceleration from 8 s to 12 s?

(a) $8\ m/s^2$

(b) $12\ m/s^2$

(c) $2\ m/s^2$

(d) $-1\ m/s^2$

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SSBCrack EXAMS

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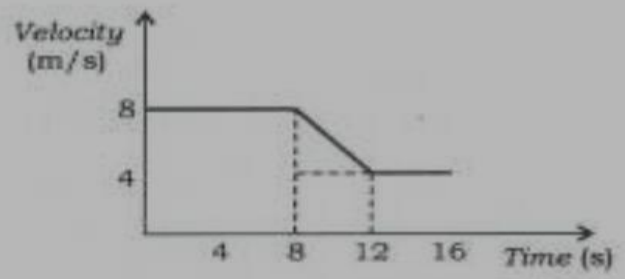

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(a) $8\ m/s^2$

(b) $12\ m/s^2$

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(d) $-1\ m/s^2$

Answer: D

6. A car starts from Bengaluru, goes 50 km in a straight line towards south, immediately turns around and returns to Bengaluru. The time taken for this round trip is 2 hours. The magnitude of the average velocity of the car for this round trip

(a) is 0.

(b) is 50 km/hr.

(c) is 25 km/hr.

(d) cannot be calculated without knowing acceleration.

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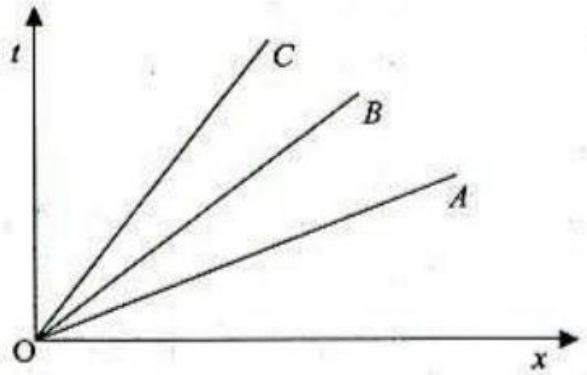
Answer: A

7.



The figure shown above gives the time (t) versus position (x) graphs of three objects A, B and C. Which one of the following is the correct relation between their speeds V_A, V_B and V_C, respectively at any instant ($t > 0$)?

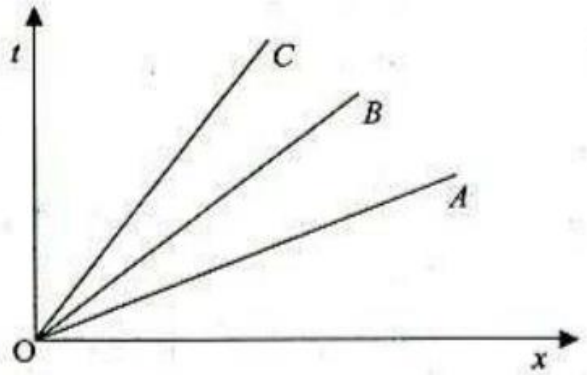
(a) $V_A < V_B < V_C$

(b) $V_A > V_B > V_C$

(c) $V_A = V_B = V_C \neq 0$

(d) $V_A = V_B = V_C = 0$

7.



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(a) $V_A < V_B < V_C$

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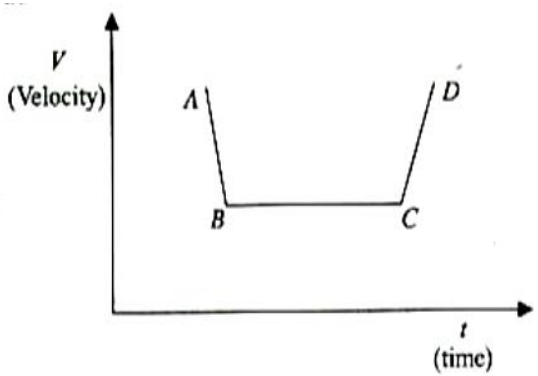
(c) $V_A = V_B = V_C \neq 0$

(d) $V_A = V_B = V_C = 0$

Answer: B

8.



In the given velocity (V) versus time (t) graph, accelerated and decelerated motions are respectively represented by line segments

(a) CD and BC

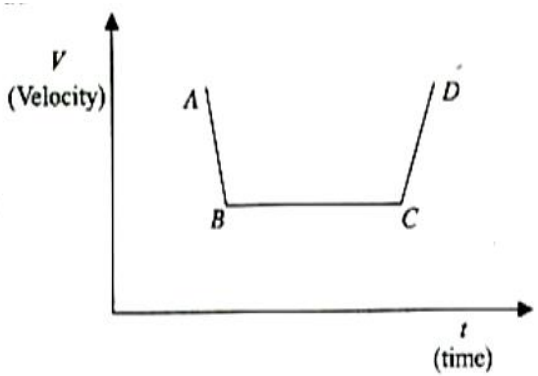
(b) BC and AB

(c) CD and AB

(d) AB and CD

Answer: C

8.



In the given velocity (V) versus time (t) graph, accelerated and decelerated motions are respectively represented by line segments

(a) CD and BC

(b) BC and AB

(c) CD and AB

(d) AB and CD

Answer: C

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SSBCrack EXAMS

9. A tennis ball is thrown in the vertically upward direction and the ball attains a maximum height of 20 m. The ball was thrown approximately with an upward velocity of

(a) 8 m/s

(b) 12 m/s

(c) 16 m/s

(d) 20 m/s

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(b) 12 m/s

(c) 16 m/s

(d) 20 m/s

Answer: D

10. A uniform motion of a car along a circular path experiences

(a) a change in speed due to a change in its direction of motion.

(b) a change in velocity due to a change in its direction of motion.

(c) a change in momentum due to no change in its direction of motion.

(d) a constant momentum due to a change in its direction of motion.

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(b) a change in velocity due to a change in its direction of motion.

(c) a change in momentum due to no change in its direction of motion.

(d) a constant momentum due to a change in its direction of motion.

Answer: B

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SSBCrack EXAMS

11. Which one of the following statements about speed and velocity is correct?

(a) Speed and velocity both are vector quantities.

(b) Speed and velocity both are scalar quantities.

(c) Speed is vector quantity and velocity is scalar quantity.

(d) Speed is scalar quantity and velocity is vector quantity.

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SSBCrack EXAMS

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(c) Speed is vector quantity and velocity is scalar quantity.

(d) Speed is scalar quantity and velocity is vector quantity.

Answer: D

12. What is the nature of velocity-time graph for a car moving with uniform acceleration?

(a) Parabola

(b) Logarithmic

(c) Straight line

(d) Exponential

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Answer: D

13. Ram records the odometer readings of his car for the distance covered from 2000 km at the start of his journey and 2400 km at the end of the journey after 8 hours. What is the average speed of the car ?

(a) 50 km/h

(b) 60 km/h

(c) 70 km/h

(d) 80 km/h

SSBCrack EXAMS

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(c) 70 km/h

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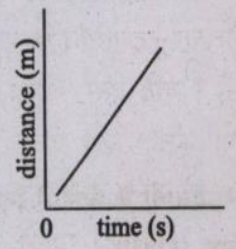
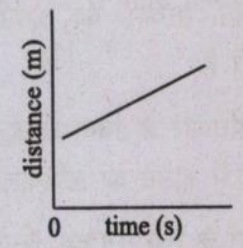
Answer: A

14. Which one of the following graphs represents the equation of motion $v = u + at$; where all quantities are non-zero and symbols carry their usual meanings ?

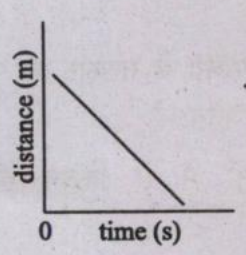
(a)



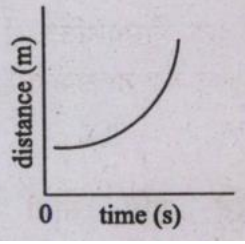
(b)



(c)



(d)



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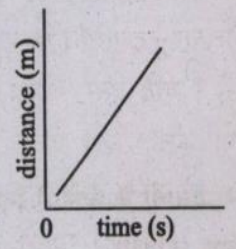
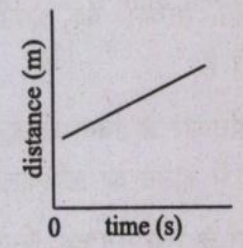
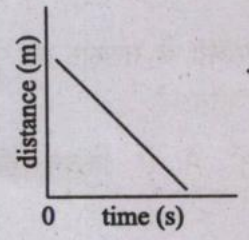


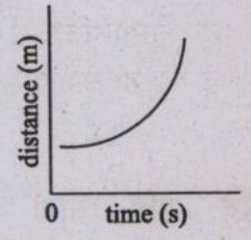
(b)



(c)



(d)



Answer: D

15. A stone is thrown horizontally from the top of a 20 m high building with a speed of 12 m/s. It hits the ground at a distance R from the building. Taking g = 10 m/s^2 and neglecting air resistance will give :

(a) R = 12 m

(b) R = 18 m

(c) R = 24 m

(d) R = 30 m

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Answer: C

16. A person travels distance πR along the circumference of a circle of radius R. Displacement of the person is

A. R

B. 2R

C. 2πR

D. 0

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A. R

B. 2R

C. 2πR

D. 0

17. The distance – time graph of a body moving along a straight path in a single direction with uniform speed will be

A. Along X – Axis

B. A line with +ve slope

C. Parallel to X – Axis

D. None of these

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18. A particle is moving in a circle of radius R with a constant speed v. Its average acceleration over the time when it moves over half the circle is :

(a) $\frac{v^2}{R}$

(b) $\frac{\pi v^2}{2R}$

(c) $\frac{2v^2}{\pi R}$

(d) 0

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(a) $\frac{v^2}{R}$

(b) $\frac{\pi v^2}{2R}$

(c) $\frac{2v^2}{\pi R}$

(d) 0

Answer: C

19. A motorcyclist drives from place A to B with a uniform speed of 30 km h^{-1} and returns from place B to A with a uniform speed of 20 kmh^{-1}. Find his average speed.

A. 12 kmh^{-1}

B. 6kmh^{-1}

C. 24 kmh^{-1}

D. 10 kmh^{-1}

19. A motorcyclist drives from place A to B with a uniform speed of 30 km h^{-1} and returns from place B to A with a uniform speed of 20 kmh^{-1}. Find his average speed.

A. 12 kmh^{-1}

B. 6kmh^{-1}

C. 24 kmh^{-1}

D. 10 kmh^{-1}

20. John is travelling from home to his school. He travels a distance of 3 km towards East , then 4 km towards North and finally 9 km towards East. Is the distance and displacement equal in this case ?

A. Yes

B. No

C. Maybe

D. Can’t say

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A. Yes

B. No

C. Maybe

D. Can’t say

21. Two forces of 5·0 N each are acting on a point mass. If the angle between the forces is 60°, then the net force acting on the point mass has magnitude close to :

(a) 8·6 N

(b) 4·3 N

(c) 5·0 N

(d) 6·7 N

$R^2 = A^2 + B^2 + 2AB\cos\theta$

$= A^2 + A^2 + 2A^2\cos\theta$

$R^2 = 2A^2(1+\cos\theta)$

$R^2 = 2A^2\left(2\cos^2\frac{\theta}{2}\right)$

$R^2 = 4A^2\cos^2\frac{\theta}{2}$

$R = 2A\cos\frac{\theta}{2}$

$R = (2 \times 5\ N)\cos\frac{60^\circ}{2}$

$= 10 \times \cos 30^\circ$

$= 10 \times \frac{\sqrt{3}}{2}$

$= 5\sqrt{3} = 5 \times 1.732$

$= 8.660 \sim 8.6\ N$

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(a) 8·6 N

(b) 4·3 N

(c) 5·0 N

(d) 6·7 N

Answer: A